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# **OTF CCSDS Mission Operations**

## **Prototype**

### **Directory and Action Service**

#### **Phase I**

### **Exit Presentation**

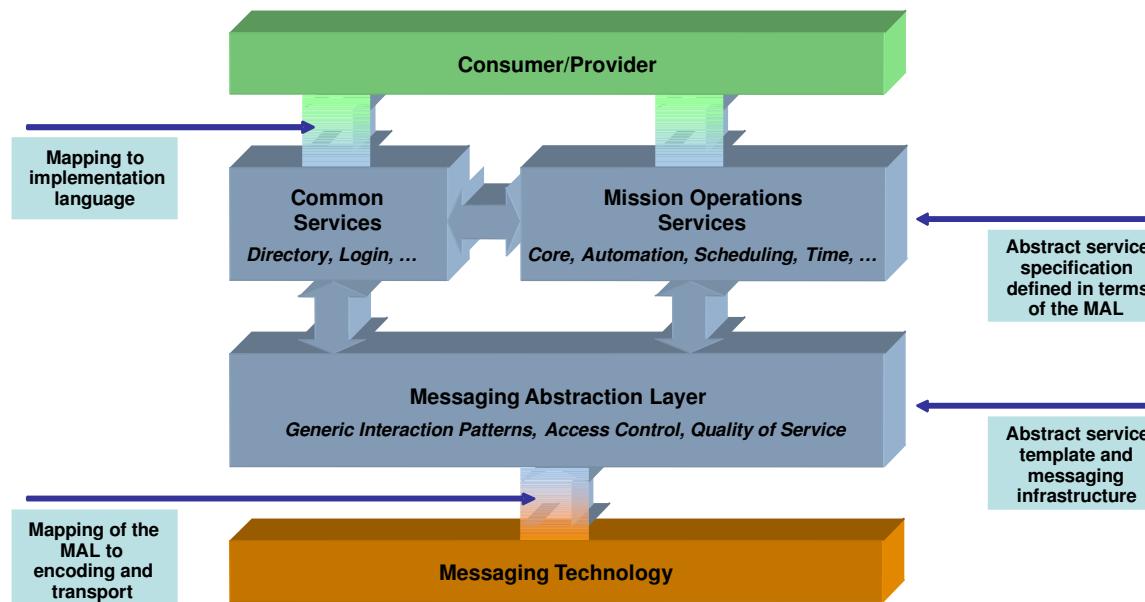
**Steve Lucord**

**02/25/2009**



# Introduction

- Mission Operations
  - Primary goal is to increase level of interoperability among Agencies





# Project Goals

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- Demonstrate the use of Mission Operations standards to implement Directory and Action Services
- Investigate Mission Operations language neutrality
- Investigate C3I XML interoperability concepts
- Integrate applicable open source technologies in a Service Oriented Architecture



# Project Benefits

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- Investigate the viability of the Mission Operations standards
- Provide feed back to the Mission Operations Working Group and NASA management
- Concrete implementation of a Service Oriented Architecture (SOA)
- Multi-center cooperation
  - GSFC : MAL Implementation
  - JPL: AMS (Asynchronous Message Service) Transport Layer
- Introduction of new technologies

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# Project Scope

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- Does not address security concerns
- Does not implement Common Model operations
- Implements minimum MAL capabilities



# Project Definition

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- Mission Operations Interoperability Constraints
  - Directory Service
    - A. Language Mapping: C, C++, Java and Python
    - B. MAL Specification: July 2007 Red Book
    - C. Service Specification
      - Common Services: September 2007 Red Book
    - D. Transport Mapping: HTTP Transport / XML encoding
  - Action Service
    - A. Language Mapping: C++ and Java
    - B. MAL Specification: July 2007 Red Book
    - C. Service Specification:
      - Common Services: April 2008 Red Book
      - Core Services: May 2008 Red Book
    - D. Transport Mapping: AMS Transport / XML Encoding



# Methodology

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- Created XML **schemas** for MAL, Common and Core constructs
- Used XML tool kits to generate object to XML (OXM) mapping code from schemas
- Implemented the most common execution paths with reasonable error checking



# Directory Service Provider

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- Implemented Methods
  - Lookup: Consumer searches for qualifying services
  - Publish: Provider advertises availability
  - Withdraw: Provider indicates service is no longer available
- Java Application
- Integrated Open Source Projects
  - Spring Web Services: [www.springframework.org/spring-ws](http://www.springframework.org/spring-ws)
  - Tomcat Servlet Container: [tomcat.apache.org](http://tomcat.apache.org)
  - Derby embedded database: [db.apache.org/derby](http://db.apache.org/derby)
  - iBatis Object Query Mapping (OQM): [ibatis.apache.org](http://ibatis.apache.org)
  - JAXB Object XML Mapping (OXM): [jaxb.dev.java.net](http://jaxb.dev.java.net)
  - JUnit: [www.junit.org](http://www.junit.org)
    - Automated unit and regression tests



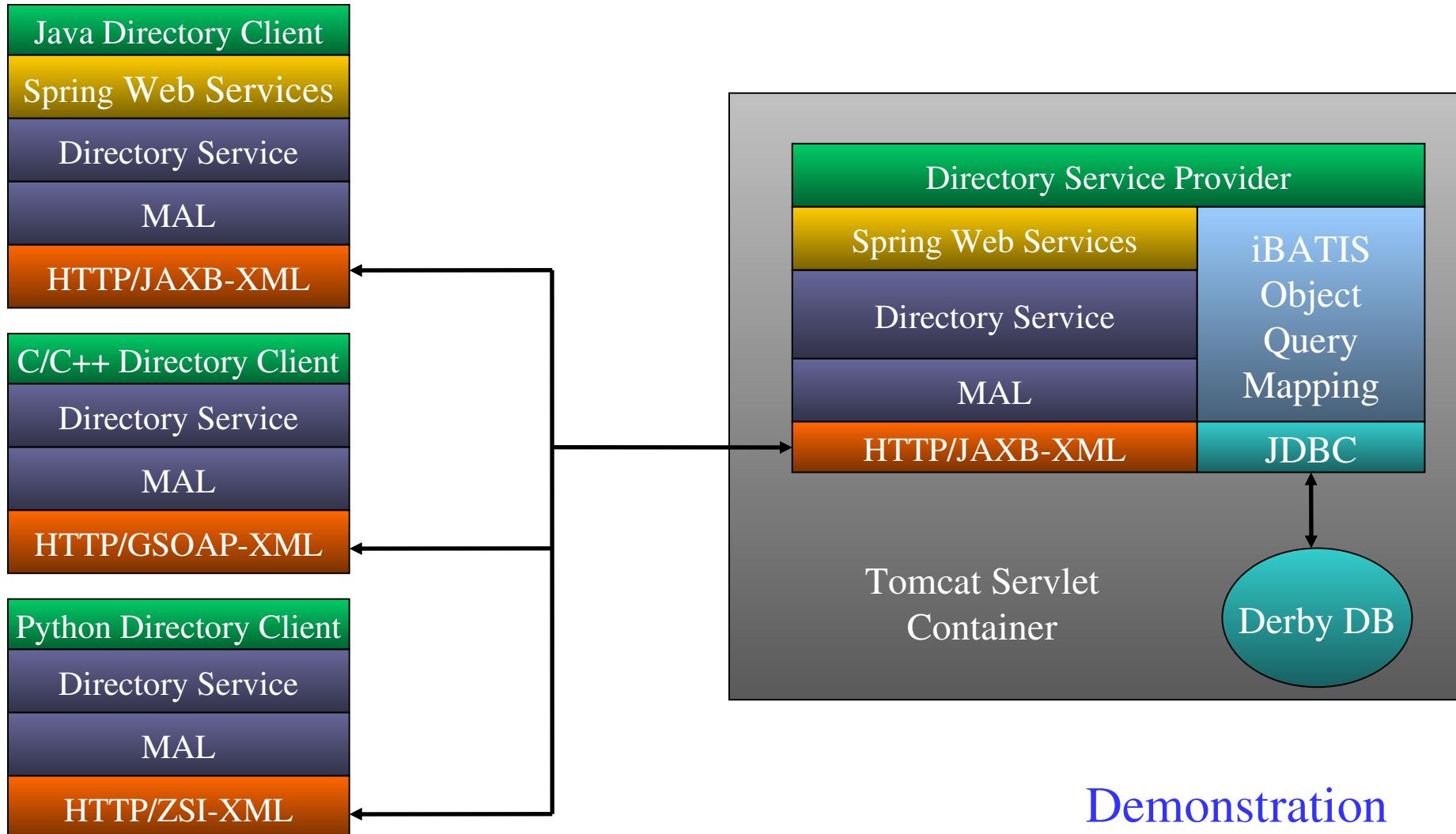
# Directory Service Clients

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- Java Client
  - Wicket Web Framework: [wicket.apache.org](http://wicket.apache.org)
  - Spring Web Services: [www.springframework.org/spring-ws](http://www.springframework.org/spring-ws)
  - JAXB OXM: [jaxb.dev.java.net](http://jaxb.dev.java.net)
- C / C++ Client
  - gSOAP OXM: [www.cs.fsu.edu/~engelen/soap.html](http://www.cs.fsu.edu/~engelen/soap.html)
- Python Client
  - Zolera Soap Infrastructure OXM: [pywebsvcs.sourceforge.net](http://pywebsvcs.sourceforge.net)



# Directory Service Interfaces





# Action Service Provider

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- invokeAction
  - Execute actions (commands)
  - Implemented only actions without arguments
- preCheckAction
  - Boolean return indicating if action would succeed
  - Not implemented
    - Not supported by COTS Command and Telemetry System
    - No MCC equivalent capability for Command



# Action Service Provider

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- C++ Application
- Integrated Open Source Projects
  - OMNIORB CORBA ORB: [omniorb.sourceforge.net](http://omniorb.sourceforge.net)
  - ACE TAO CORBA ORB: [www.cs.wustl.edu/~schmidt/TAO.html](http://www.cs.wustl.edu/~schmidt/TAO.html)
  - gSOAP OXM: [www.cs.fsu.edu/~engelen/soap.html](http://www.cs.fsu.edu/~engelen/soap.html)
  - Boost C++ Libraries: [www.boost.org](http://www.boost.org)
- Dependencies
  - L3 InControl Command Server
    - Vendor permitted continued evaluation after trade study
  - AMS (Asynchronous Message Service)
  - JAMS (JSC Front End to AMS)



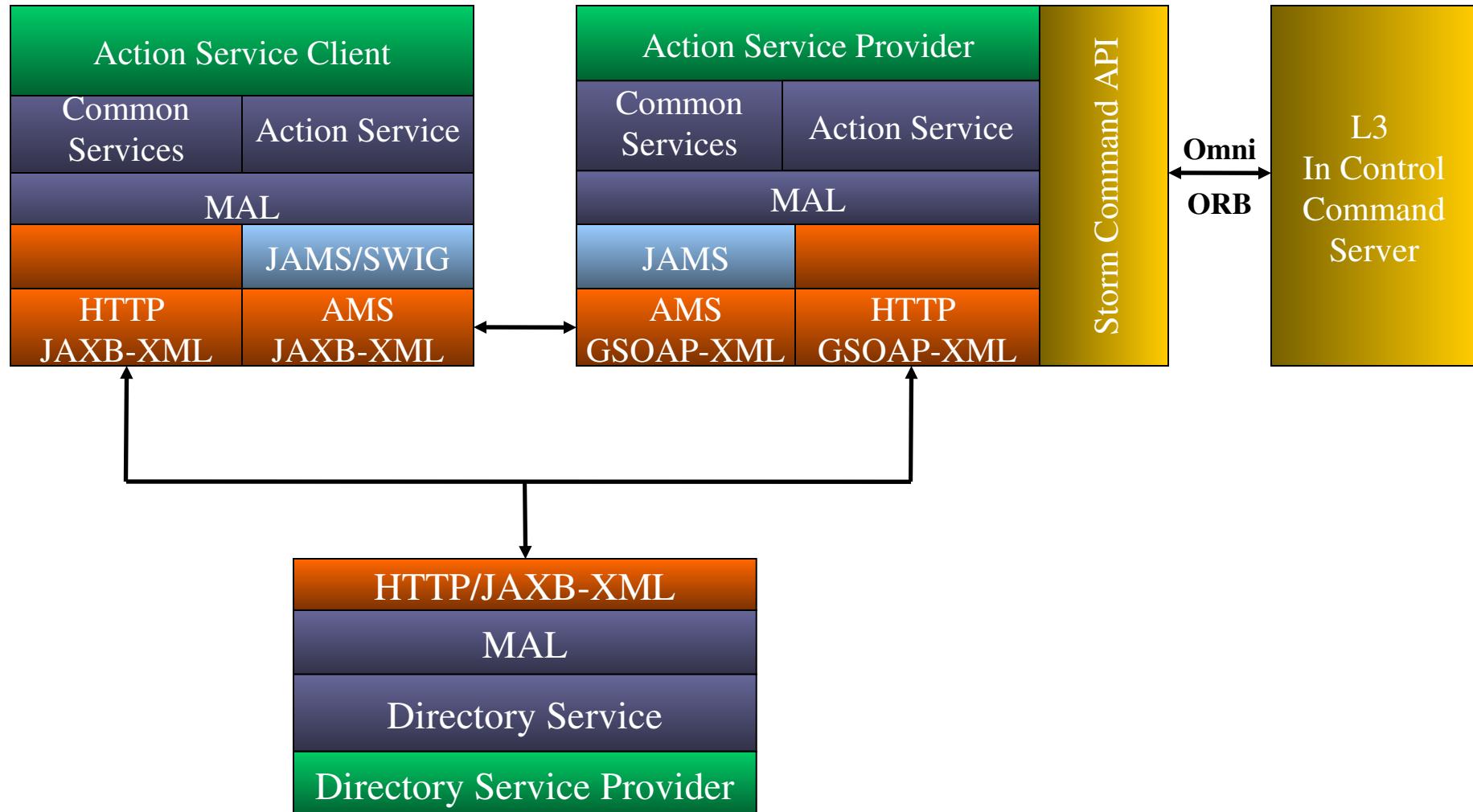
# Action Service Client

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- Browser Based User Interface
- Integrated Open Source Projects
  - Java Language
  - Tomcat Servlet Container: [tomcat.apache.org](http://tomcat.apache.org)
  - JAXB OXM: [jaxb.dev.java.net](http://jaxb.dev.java.net)
  - Web Application Framework: [wicket.apache.org](http://wicket.apache.org)
  - SWIG C/C++ Wrapper: [www.swig.org](http://www.swig.org)
- Dependencies
  - AMS (Asynchronous Message Service)
  - JAMS (JSC Front End to AMS)

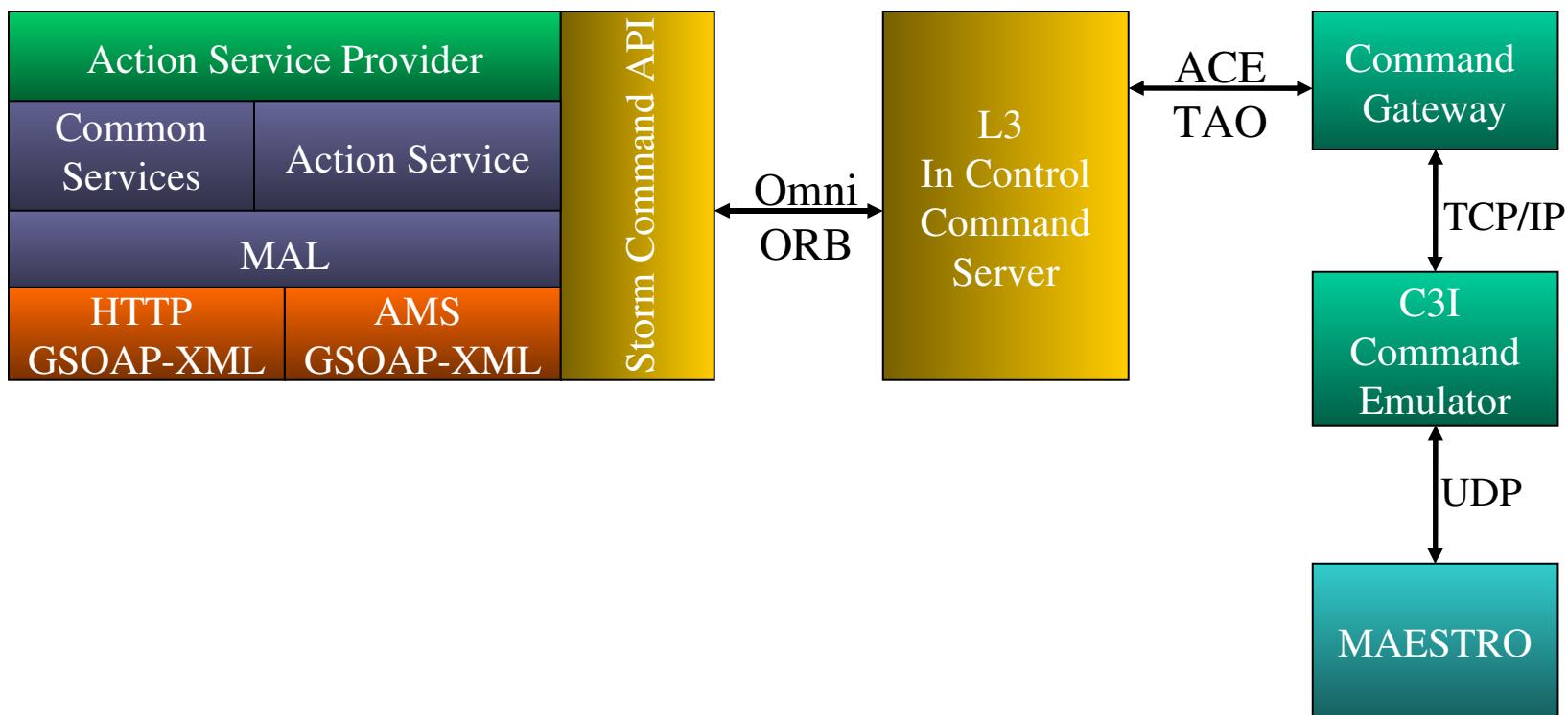


# Action Service Interfaces



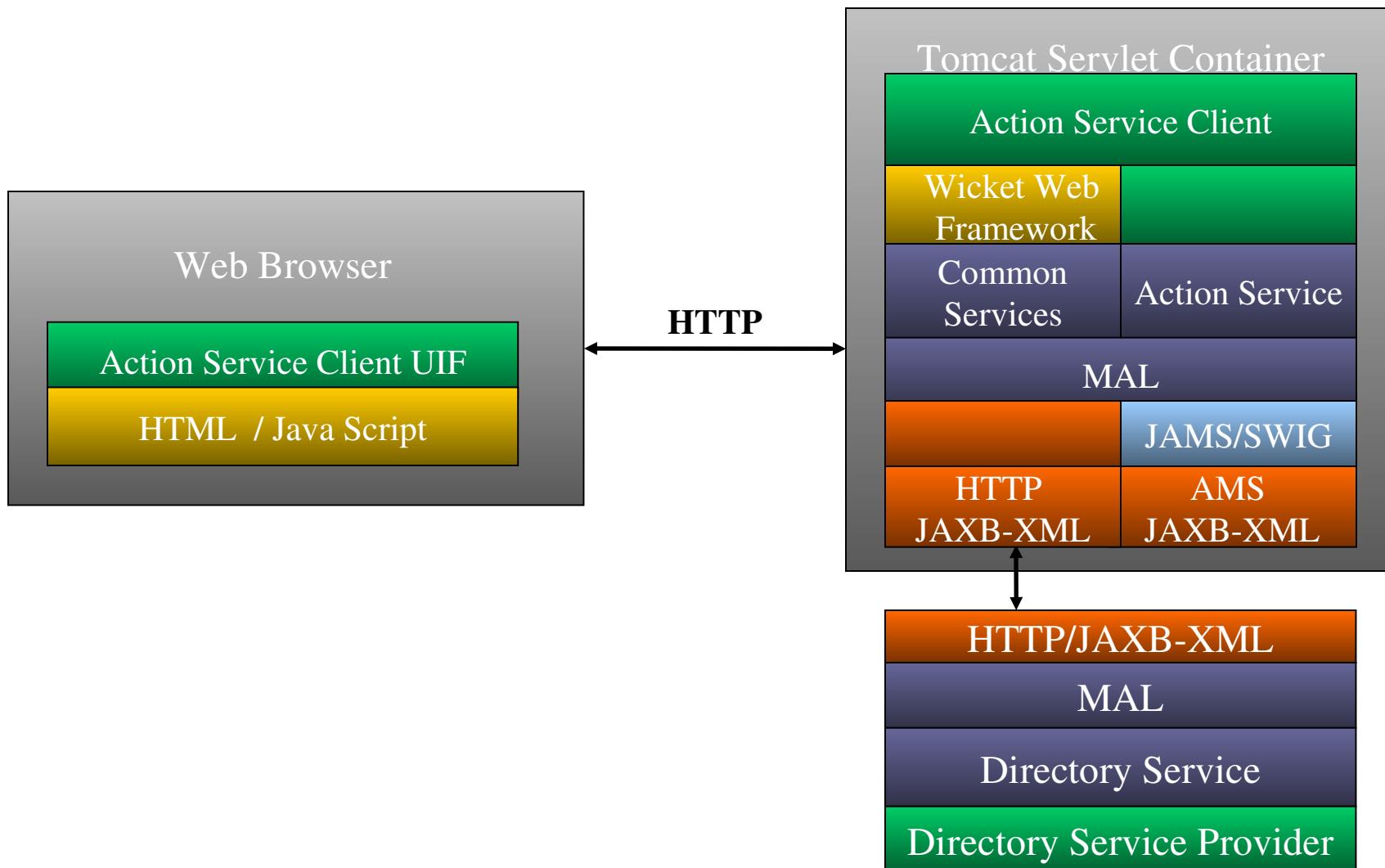


# Action Service Proxy



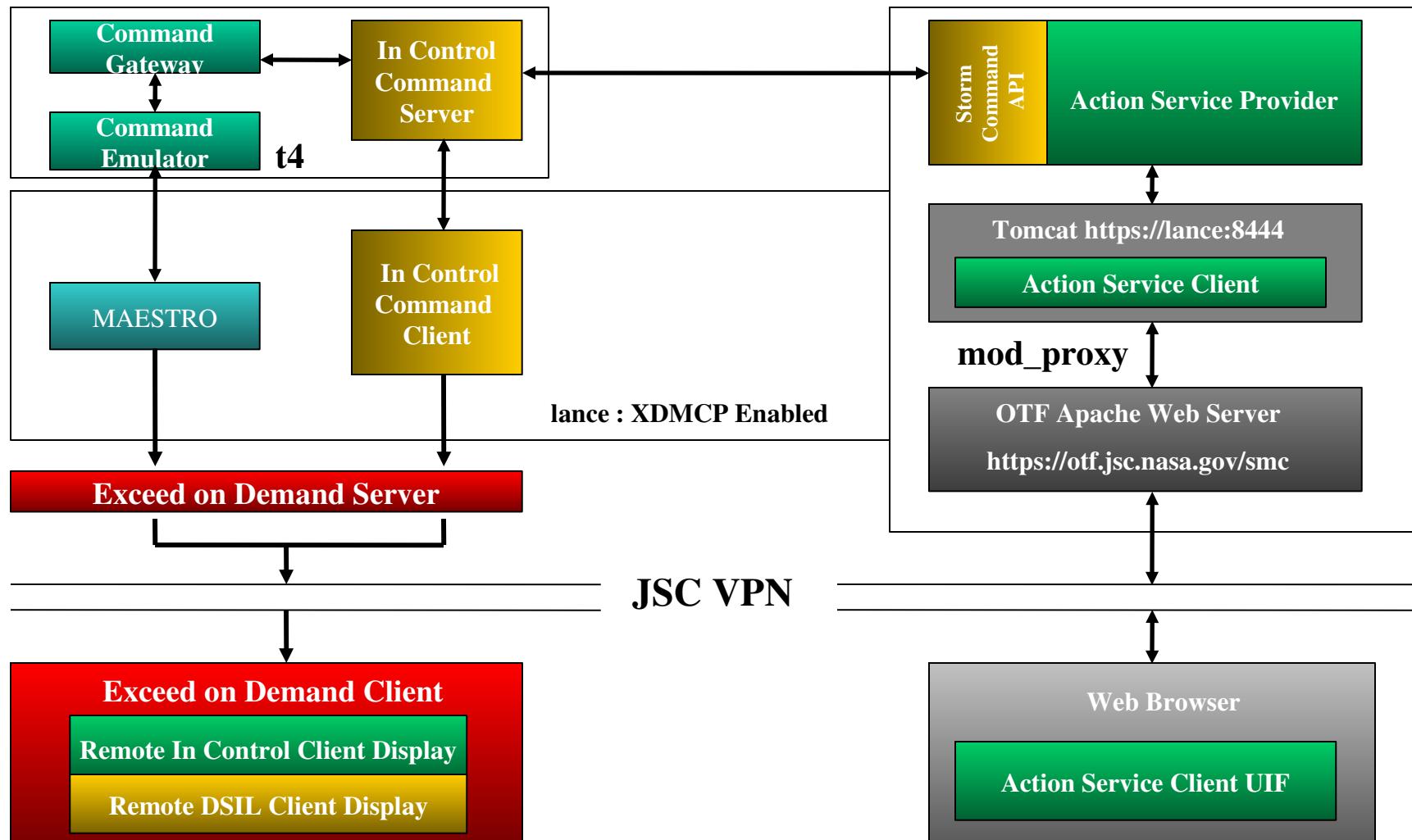


# Action Service Client



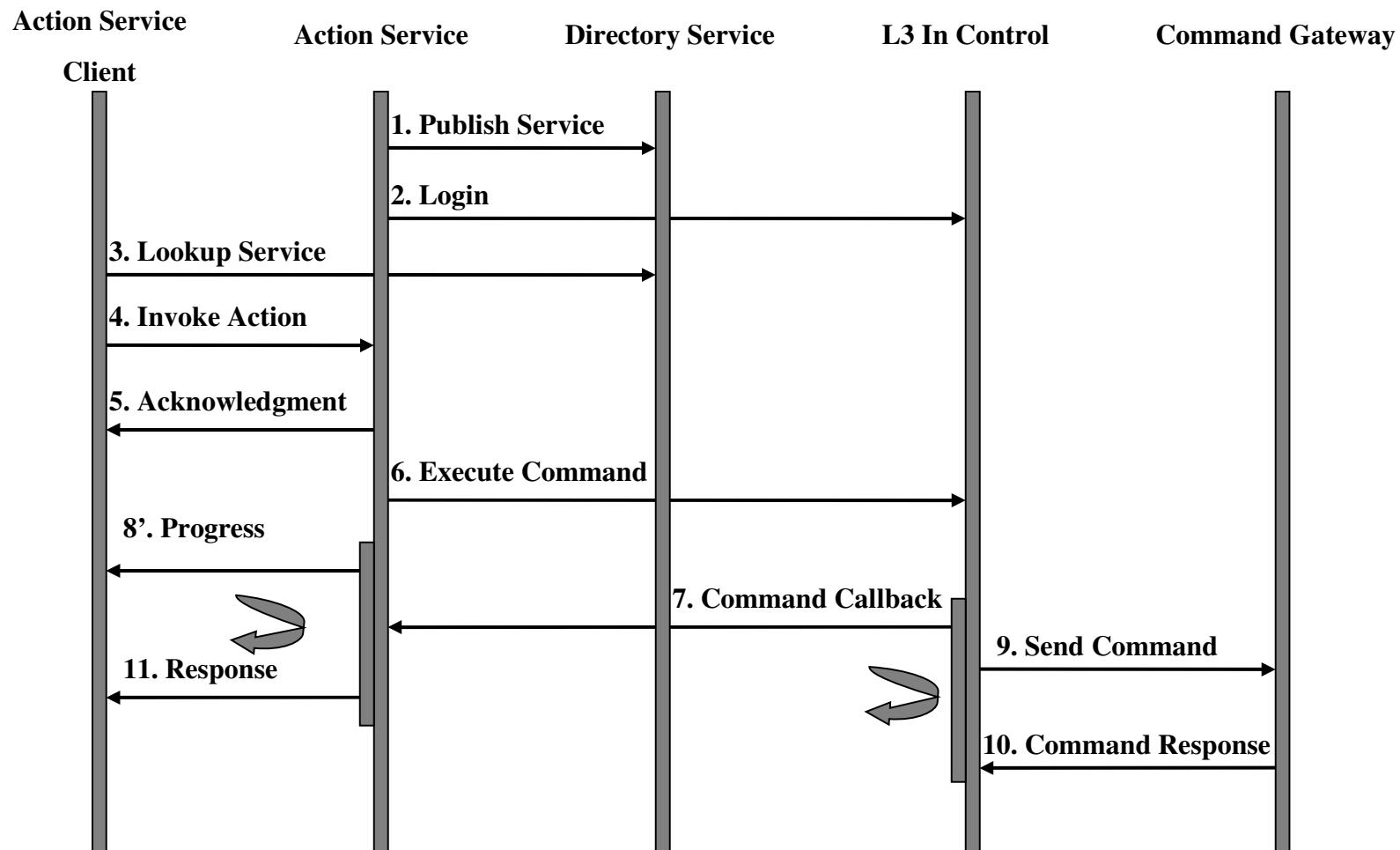


# Demonstration Architecture





# Demonstration Flow





# Results

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- Identified modifications to implement manned spaceflight requirements (separate presentation)
- Eighteen (18) RIDS against Directory Service
- Seven (7) RIDS against Action Service
- Validated MO interoperability in regards to language neutrality
- Validated C3I XML interoperability concepts



# Results Continued

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- Specification defers many data format issues to the service configuration which is outside the scope of the documents
  - No discovery mechanism for the available commands with parameters
  - Interface for command uplink provides only an argument list for parameter values.
    - No parameter type
    - No engineering units
    - No operational limits



# Results Continued

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- Service Oriented Architecture (SOA) requires long term investment
  - Interfaces must be negotiated and designed for reuse
  - Software developer training
- Mission Operations does an excellent job defining the interfaces and service specifications
  - Provides business requirements to drive the architecture
  - Potential to absorb up front cost of interface design
  - Specifies defendable and versionable interfaces



# MO Lessons Learned

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- Necessary to write a blue book specifying the schemas for the Mission Operations data structures
  - The consumer and provider schema must be in agreement for interoperability



# XML Lessons Learned

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- Sufficient tool support for XML encoding
- Support varies by language
  - C/C++ require large amounts of generated code
  - C/C++ require hand written memory allocation logic
  - Java / Python have basic XML support available as libraries or packages



# XML Lessons Learned

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- Investigation to determine bandwidth issues for large amounts of XML data is necessary
- Schemas to define data formats must be defined and agreed upon for C3I to succeed



# Conclusions

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- Additional commanding capabilities are needed for manned space flight
- Validated MO interoperability in regards to language neutrality
- Validated C3I XML interoperability concepts
  - Contingent upon schema definition
- SOA is a long term investment



# Contacts

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# Thank You

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- Questions



# SOA SLOC Matrix

Components	Language	SLOC Count	COCOMO Estimate (Months)
Directory Web Service	Java	2,028	3.91
Directory Web Service Client	Java	1,569	3.75
	C	366	0.84
	Python	212	0.52
Action Service	C++	6,370	16.30
Action Service Client	Java	1,519	3.72
		<b>12,064</b>	<b>29.04</b>
<b>Generated Components</b>			
OXM Services	C++	14,443	39.59
	C	9,887	26.93
	Java	1,512	3.70
	Python	430	0.99
OQM Services	Java	1,579	3.88
MAL SWIG Interface to JAMS	Java	75	0.16
	C	298	0.67
		<b>28,224</b>	<b>75.92</b>
		<b>40,288</b>	<b>104.96</b>

[Return](#)



# Directory Service RIDS

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- Distributed nature of directory service is not hidden from the clients
  - Client performs iterative lookup to resolve URI
  - Client performs addition of external links
- Publish service is not specified to take action if node does not exist
- Extra information attribute not used to aid problem resolution for errors



# Action Service RIDS

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- Information mismatch between progress updates and data archived in the Common Model
- Time triggered actions not specified
- Extra information attribute not used to aid problem resolution for errors

CCSDS Mission Operations  
Directory Service Demonstration

Screen Shots

## 1. Directory Service Home Page

Directory Service - Mozilla Firefox

File Edit View History Bookmarks Tools Help

https://otf.jsc.nasa.gov/smc/directory-ws-client/directory-service-list.0

Getting Started Latest Headlines http://

Directory Listing For /services/... Directory Listing For /services/... Spacecraft Monitor and Control... Directory Service Action Service

**Spacecraft Monitor and Control - Directory Service**

Pages

Directory Service List Directory Service Publish Directory Service Filter

	Domain	Network Zone	Session Type	Session Name	Area	Type	Version	Provider Name	Service URI
<input type="checkbox"/>	gov.nasa.jsc.otf.action	GROUND	LIVE	Prototype	1	1	1	ActionService	jams:dd12.jsc.nasa.gov:SMCPr

Showing 1 to 1 of 1 << < 1 > >>

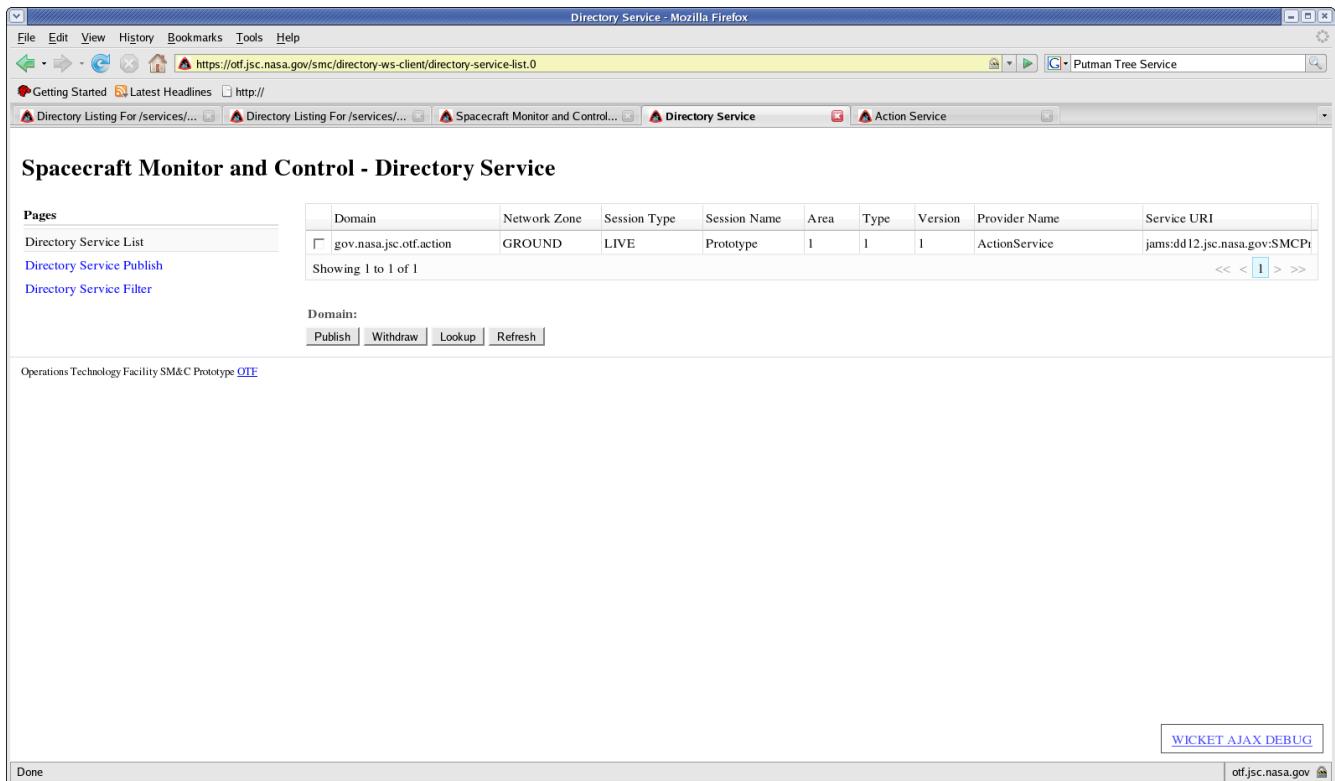
Domain:

[Publish](#) [Withdraw](#) [Lookup](#) [Refresh](#)

Operations Technology Facility SM&C Prototype [OTF](#)

WICKET AJAX DEBUG

Done [otf.jsc.nasa.gov](#)



	Domain	Network Zone	Session Type	Session Name	Area	Type	Version	Provider Name	Service URI
<input type="checkbox"/>	gov.nasa.jsc.otf.action	GROUND	LIVE	Prototype	1	1	1	ActionService	jams:dd12.jsc.nasa.gov:SMCPr

## 2. Directory Service Lookup

Directory Service - Mozilla Firefox

File Edit View History Bookmarks Tools Help

https://otf.jsc.nasa.gov/smc/directory-ws-client/directory-service-lookup.2

Getting Started Latest Headlines http://

Directory Listing For /services/... Directory Listing For /services/... Spacecraft Monitor and Control... Directory Service Action Service

### Spacecraft Monitor and Control - Directory Service

Pages

Directory Service List

Directory Service Publish

Directory Service Filter

#### Service Entry

Domain	gov.nasa.jsc.otf.action	Network Zone	GROUND
Session Type	LIVE	Session Name	Prototype
Source Session Type	Choose One	Source Session Name	
Service Area	1	Service Type	1
Service Version	1	Provider Name	ActionService

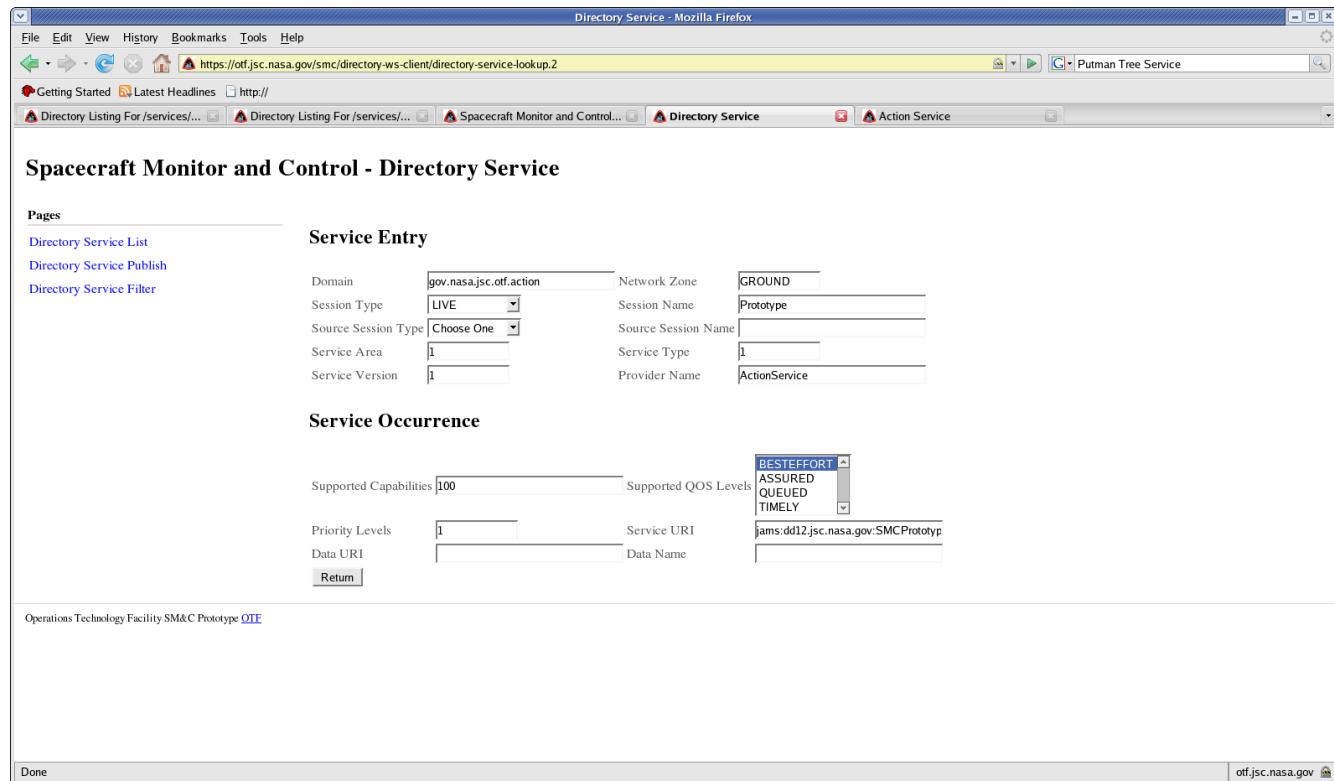
#### Service Occurrence

Supported Capabilities	100	Supported QOS Levels	BESTEFFORT ASSURED QUEUED TIMELY
Priority Levels	1	Service URI	jams:dd12.jsc.nasa.gov:SMCPrototyp
Data URI		Data Name	

Operations Technology Facility SM&C Prototype [OTF](#)

Return

Done oftf.jsc.nasa.gov



### 3. Directory Service Filter

Directory Service - Mozilla Firefox

File Edit View History Bookmarks Tools Help

https://otf.jsc.nasa.gov/smc/directory-ws-client/directory-service-filter.4

Getting Started Latest Headlines http://

Directory Listing For /services/... Directory Listing For /services/... Spacecraft Monitor and Control... Directory Service Action Service

**Spacecraft Monitor and Control - Directory Service**

Pages

Directory Service List

Directory Service Publish

Directory Service Filter

**Service Entry**

Domain	<input type="text"/>	Network Zone	<input type="text"/>
Session Type	<input type="button" value="Choose One"/>	Session Name	<input type="text"/>
Source Session Type	<input type="button" value="Choose One"/>	Source Session Name	<input type="text"/>
Service Area	<input type="text"/>	Service Type	<input type="text"/>
Service Version	<input type="text"/>	Provider Name	<input type="text"/>

**Service Occurrence**

Supported Capabilities	<input type="text"/>	Supported QOS Levels	<input type="button" value="BESTEFFORT"/> <input type="button" value="ASSURED"/> <input type="button" value="QUEUED"/> <input type="button" value="TIMELY"/>
Priority Levels	<input type="text"/>	Service URI	<input type="text"/>
Data URI	<input type="text"/>	Data Name	<input type="text"/>

Operations Technology Facility SM&C Prototype [OTF](#)

Done [otf.jsc.nasa.gov](#)

## 4. Directory Service Withdraw

Directory Service - Mozilla Firefox

File Edit View History Bookmarks Tools Help

https://otf.jsc.nasa.gov/smc/directory-ws-client/directory-service-list.8

Getting Started Latest Headlines http://

Directory Listing For /services/... Directory Listing For /services/... Spacecraft Monitor and Control... Directory Service Action Service

Spacecraft Monitor and Control - Directory Service

Pages

Directory Service List

Directory Service Publish

Directory Service Filter

Domain Network Zone Session Type Session Name Area Type Version Provider Name Service URI

No Records Found

Domain:

Publish Withdraw Lookup Refresh

Withdraw for Domain gov.nasa.jsc.otf.action successful.

Operations Technology Facility SM&C Prototype OTF

WICKET AJAX DEBUG

Done oftf.jsc.nasa.gov

